FINAL REPORT

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INNOVATION AND COMMERCIALIZATION OF SASKATCHEWAN FEEDSTUFFS: PROVISION OF INFRASTRUCTURE TO ENHANCE THE VALUE AND UTILIZATION OF FEEDSTUFFS

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RESOURCE CENTRE

Final Report

to

Canada-Saskatchewan Agri-Food Innovation Fund

Innovation and Commercialization of Saskatchewan Feedstuffs

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Executive Summary

The Prairie Feed Resource Centre is an industry driven partnership between both levels of government, feed ingredient producers and processors, and the University of Saskatchewan. PFRC as a non profit corporation contracts its operations under agreement to the Department of Animal and Poultry Science at the University of Saskatchewan. This arrangement has provided maximal synergy to utilize human and physical resources to the greatest benefit. The mandate of the PFRC is to provide support and leadership in key areas of feeds, research and development as directed by industry affiliates. Activities take the form of consultation and collaboration, the designing and carrying out of research and development initiatives. The approach is one of integration, providing support from conception, research and development, through and including commercialization by technical market support. Leadership is shown through providing a forum and a proactive process of technology transfer.

The Prairie Feed Resource Centre was provided $600,000 from the Agri-Food Innovation Fund for support of core infrastructure in the form of a director, researcher, and office support. PFRC has been successful in taking this core funding approach and providing through industry participation projects that have had substantial economic impact. Current funding for contributions has now shown that 43% would have been government contributions to that of 57% coming from industry for projects.

Projects undertaken by the Prairie Feed Resource Centre fall into several categories. PFRC had targeted basically nine areas for development and value increase. These were as follows: canola meal, barley, feed wheat, pulses, oats, forages, specialty crops and processed products, crop residues, and agricultural byproducts and feed additives.

In the area of crop residues and byproducts one major project was that of developing grain screening pelleting plants. This industry continues to grow and at present accounts for 140,000 tonnes of product. This industry has the potential to produce 600,000 tonnes of product. At present the economic impact of such a program is $5.6 million in freight cost savings to crop producers in Saskatchewan as well as $14 million per year of value added economic activity and if animals are fed in Saskatchewan with the product would generate another $38.5 million of value through animal gain alone.

Other projects under the crop residues and byproducts included improving the economic value and feeding value of oat hulls and looking at other byproducts such as those arising from value added activities such as caraway meals, etc. There were specific projects looking at improving the nutritional value of evaluating and means to improve value of some of our current feed grains. Among these were superior hulless barley varieties, superior feed pea varieties, the

development of a low lignin high oil oat and improving the feeding value of canola meal. Other project activities looked at the development of very highly specialized feedstuffs arising from either crop processing or means of processing or from combining feedstuffs. This would be for the creation of feedstuffs with unique characteristics. Some of these products were the creation of organic horse feeds under the brand name "Genesis", looking at improving peas through a product called Peas Plus, creation of the pea-canola blends, ExtraPro, A-Plus Supergreen, and now Lin Pro. These specialty products created have all expanded the market place and perception of the original feedstuffs.

One major initiative that was undertaken under the program has been the development of prairie based feedstuffs for aquaculture purposes. Much of this work is at the initial stages, however, the potential and promise of new feeds being derived from aquaculture from Saskatchewan grown feedstuffs is good. Feeds such as pea protein concentrates arising from the processing of feeds, use of high protein canola meals, and the use of flaxseed to provide substitutes for fish meal and fish oil in aquaculture diets is good. Commercial entities have been found to drive some of these developments forward. These commercial entities would include producer groups, a processing group located in Saskatchewan, and a market group which has formed a strategic alliance with the Prairie Feed Resource Centre for the development of these feedstuffs. EWOS, the Norwegian based firm, represents a substantial market for our prairie based feedstuffs.

PFRC has put forward a vigorous technology transfer program that had to accompany the development and commercialization of some of these projects. PFRC, in addition to maintaining a technology transfer program for the industry at large, technically supported through seminars and technical bulletins the manufacture, development, and marketing of many of the new feed developments and feed uses.

PFRC has also been involved in educational type programs in terms of putting on feed courses and establishing links with other agencies on a domestic and international basis with groups such as CIGI in Winnipeg and the MAFIC Feed Centre in Beijing. The direction chosen by PFRC has had a good response to it from industry. It is expected that work will continue along much of the lines and direction that were established during the course of this project.

There have been areas which now have emerged which would take priority. One of these areas is in the area of crop processing. It is felt that crop processing should be looked at from a multi-disciplinary and interdisciplinary approach, i.e. we should be looking at crop processing from the area of yielding co-products that can be used for feed, food, and industrial uses. The current high interest in the development of ethanol plants is something that will have to be grappled with and certainly these are opportunities for not only garnering projects, but to have substantial economic contribution to the economy of the province. As indicated, many of these projects are done in

coordination with other groups and/or involves strategic industry partners. As a result identification of a singular entity responsible is not always clear. Irrespective, PFRC in the preceding projects has played a key role in innovation, recognizing opportunities, and development that must take place for economic contributions. The unique position and mandate of the PFRC allows it to play a role from its own original concept to facilitate the development of other technologies from research or industry.

In short, the PFRC in its approach has met the requirements set out before it in the Agri-Food Innovation Fund project. It is also felt that the project has been successful in not only doing the specific projects, but it has opened up a new perception in how this key area within the crops-livestock interface is viewed and perceived by the public. Feed is less and less being viewed as a second grade cousin, but rather now is taking its rightful role as part of a much larger system of how we view agriculture.

Canada-Saskatchewan Agri-Food Innovation Fund

Innovation and Commercialization of

Saskatchewan Feedstuffs

Introduction

This final report follows and describes the pertinent activities for the period of time from October 1997 through to March 31st, 2001. The report, however, gives much greater attention and detail to the final reporting period from April 1st, 2000 to March 31st, 2001.

The Prairie Feed Resource Centre is an industry driven partnership between industry, governments, and the University of Saskatchewan dedicated to research and development of Saskatchewan and or prairie feedstuffs. As a formal entity its operation is new and continues to grow and develop. The Prairie Feed Resource Centre and the Agri-Food Innovation Fund funded programs and projects have gone through a process of maturation over the period of this project. The degree of sophistication obtained and leadership provided to the feed and feed ingredient industry has been substantial. During this period agriculture in Saskatchewan has undergone considerable changes. The changes, however, were responded to and in actual fact perhaps have become opportunities for increased development in this key critical sector of Saskatchewan agriculture.

Project Objectives

The project has as its main objective: ***To strengthen the long term competitiveness of feed ingredient producers, livestock producers, and feed processors by feed product innovation, development, research, and technical support for commercial market development and technology transfer.*** The tools by which this feed product innovation and development would take place, was through the development of feeds with new forms and composition, development of new feedstuffs, and enhancing existing feedstuffs through various means of processing, biotechnology, genetic improvement, computer modeling, and final feed form.

The central mandate of the Prairie Feed Resource Centre (PFRC) basically can be subdivided according to economic potential for the various feed ingredients and feed additives. The PFRC had targeted nine areas for development and value increase as follows: canola meal, barley, feed wheat, pulses, oats, forages, specialty crops and processed products, crop residues, and agricultural byproducts and feed additives. The industry driven activities within these areas were also ones that met the objectives of the Agri-Food Innovation Fund project. The reporting

structure for this report shall follow the general guidelines indicated by AFIF. However, under the category of project activities including results and discussions and implications for further development will follow according to the nine major categories of feed ingredients and/or major projects that were undertaken under the Agri-Food Innovation Fund program. This reporting system will provide a clear indication of progress relative to the defined areas of opportunity to increase the value of prairie grown feed ingredients and feed additives as well as the potential for further value added activities.

The very mandate of the PFRC and the way research and development takes place today requires the input of many individuals within the system. This means participation by industry so that you have commercialization or end point in mind. It also involves basic research and the transference and adaptation of that technology for use by the commercial industry. In many instances the PFRC had to play a leadership role, a collaboration role, and a role of helping to initiate projects which it may or may not have been involved in physically carrying out the activities. Nonetheless, the strategic industry partners should be recognized. These strategic industry partners made up of many of the commodity groups such as the Canola Development Commission, Saskatchewan Pulse Crop Board, the pork industry, the beef industry, and other private companies involved in sale of forages and other feed commodities were key and critical to the level of success that was achieved in this project. In addition, there were strategic alliances made with many of the groups at the University of Saskatchewan. The Department of Animal and Poultry Science has been a key and critical group that had a major role to play in the Prairie Feed Resource Center's capability to deliver on these projects. As a continuous process, strategic planning and program development is an undergoing process within industry, research groups, and other sectors. Through the PFRC Board's guidance and from advisors from government agencies and industry, specific target activities were ongoing and many have continued to grow and develop.

PROJECT ACTIVITIES

1. Byproducts and Crop Residues

a) Grain Screening Pelleting Plants

One of the earliest recognized opportunities and one that was originally listed in the activities to be done under the Agri-Food Innovation project was that of developing grain screening pelleting plants to capture potential benefits back to the crops and livestock industry. The development of grain processing facilities has been one of the major project initiatives for the PFRC. The development of a cereal, oil seed and pulse screening processing industry were undertaken with the grain screening pelleting facilities at Melville (Parkland Processors), Weyburn (Weyburn Inland Terminal), and Wilkie (West Central Pelleting). Other requests for less intensive work involving the use of processed grain screening were attended to for

the Prince Albert group and for Walker Seeds at Tisdale. The work for the latter two involved working in an advisory capacity as well as providing nutrient feed analysis support to complete their feasibility studies. The work for the Wilkie, Melville, and Weyburn group was begun at the initial stages of development involving feasibility studies through to working with the new entities in an operating mode. For the Melville group it involved working with Zetta Management (John Perrson) and with the Weyburn Inland Terminal group directly (Sandy McCormick, Norm Flaten). Work with these two groups involved eight meetings of which three involved major presentations to farmers and shareholders, as well as working in an advisory capacity. The Wilkie group involved initial work with Earnest and Young and with the Board of Directors of West Central Pelleting. There was a total of nineteen meetings with the West Central group, most involving presentations to promote the use of grain screenings and facility development. Major advisory initiatives were undertaken with these groups involving technology transfer and feed technology support by Prairie Feed Resource Centre people as well as those from the Department of Animal and Poultry Science. The initiatives undertaken for these groups had fees attached. These fees, however, were only a minor portion of the assistance had they been costed accordingly. The time spent and technology generated to support these initiatives were based on previous research and development funded by private groups and some from publicly funded research. Because these projects were not in conflict, results could be directly applied to the benefit of these groups.

In addition, the Prairie Feed Resource Centre has been leading the initiatives in utilization, research of processed screenings, and has with Dr. John McKinnon, the Beef Chair, completed two major research projects on cereal screenings use and one major project on canola screenings use. Further, Vern Racz, John McKinnon, and Murray Feist have published through Saskatchewan Agriculture and Food a detailed booklet on processed screenings use for cattle. This publication is targeted for use by livestock producers. The research on grain screenings use has also supported two graduate students under John McKinnon, that of Steven Pylot and Tennis Marx, who is now a feedlot specialist in Alberta.

It is estimated that 600,000 tonnes of dockage are available in Saskatchewan each year. At present, a 140,000 tonne processing industry has been developed through these three dedicated processing plants (Wilkie, Weyburn, and Melville) and through existing feed millers. It should be noted that the Wilkie plant is the largest feed processing plant in Saskatchewan. This industry now represents to Saskatchewan value added processing activity of $14 million per year, saving to Saskatchewan crop producers of $5.6 million in freight costs and further it will support the backgrounding and feeding activity of 140,000 beef calves for an added value of the animal gain alone of $38.5 million. It has been stated that the Wilkie plant alone has contributed $32 million of real dollar activity to the area over

the last 2 ½ years. This industry now has plans for expansion in the Wolseley and Kelliher areas, both of which the PFRC is assisting in the development of their plans. It should be indicated that these changes in development did not come easily and require a team effort. In the instance of grain processing or dockage processing facilities for screenings, much negativity and resistance by grain handlers had to be overcome. The potential, if totally capture, for this industry could mean another $60 million of yearly activity from value added processing and $18 to $20 million worth of freight savings to crop producers and feed supplies adequate to background 500,000 calves for approximately $150 million worth of animal gain.

b) Grain Screenings for Poultry Diets

The project utilizing grain screenings for poultry diets was a direct response to industry requests. The refuse screenings or No. 2 feed screenings that are used in the grain screening pelleting plants creating products for beef cattle are not suited for poultry or for swine. However, No. 1 feed screenings represent a potential poultry feed and also swine feed. To investigate the utility of No. 1 feed grain screenings for poultry a project was initiated with funding of $7500 from industry sources plus funding of $7500 of matching funds from the Agriculture Development Fund. The project was under the leadership of the poultry extension person (Guillaume Audren), Dr. Hank Classen, Department of Animal and Poultry Science, and the Prairie Feed Resource Centre. The objectives of the project were to assess the feeding value of locally produced higher quality grain screenings for poultry. The project has been completed with large scale poultry feeding trials as well as looking at digestibility and chemical analysis work for poultry utilization. The results have been applied to industry through the poultry extension professional, Guillaume Audren, and through producers that participated in the project. The impact of a project of this type not only finds a ready and economic market for No. 1 feed screenings into the poultry and the swine industry, but also enhances programs that look at cleaning grain on the prairies and retaining cost benefits to Saskatchewan.

c) Improving the Nutritional Value of Oat Hulls for Ruminant Animals

The funding for this project totalled $107,600. Contributions were received from three industry sources: Saskatchewan Wheat Pool $20,000, CanOat Milling $10,000, FinnFeeds International $10,000 with matching funds from the Canadian Adaptation and Rural Development in Saskatchewan (CARDS), plus an NSERC industrial post graduate scholarship. The project was carried forward by the PFRC and Dr. John McKinnon, Beef Industry Chair. The objectives of the project were as follows: to evaluate the potential of on farm processing systems such as ammoniation and urea treatment on the nutritional value and thus marketability of oat hulls as a ruminant feed and to evaluate the effects of various

cocktails of fibre degrading enzymes on the digestibility and thus the nutritional value of oat hulls when fed to ruminants. Finally, the objective was to develop a system of processing and/or enzyme application that would be effective for improving the digestibility and therefore the value for oat hulls.

Results of the project: Ammoniation of oat hulls: This aspect of the project involved a M.Sc. student, Ryan Thompson, using this as the main area of his research work. Ammoniation of oat hulls was found to increase dry matter digestibility of the hulls in rumen fluid and in samples of the hulls placed in fistulated animals. A second phase of the research work involved batch ammoniation of oat hulls as would be found on a farm in evaluating their feeding value in animal trails. It was shown in the animal trials that the oat hulls responded quite well to ammoniation and made a viable and economic alternative for processing oat hulls and utilization at the farmgate level. The graduate student worked with industry and one of the principal oat processing plants to put into place several pieces of literature on feeding oat hulls, demonstrated ways of ammoniating oat hulls to improve their economic value, and made farm calls to assist producers. The other phase of the project which involved enzyme treatment of the oat hulls was carried on by Dr. Peiqiang Yu, who is a post doctoral fellow. Dr. Yu had done intensive work with enzymes looking at their ability to degrade fibre use of oat hulls. As such two papers have been published on the utilization of enzymes on oat hulls. It was found that the enzymes, although effective, would be uneconomic to use as a method to break down the oat hulls. This project has now been discontinued, but has given us valuable information in terms of enzyme utilization. A second area which grew from the oat hulls work was the development of a low lignin hulled high oil oat. In the oat hull work it was found that some oat hulls had lower digestibility and some had much higher digestibility. Specific samples of oats were then identified as to which ones had higher digestibility and the reasons for that. It was found that the ones with high digestibility also had a very low lignin content and this had a genetic basis making it a trait of particular varieties.

At present there are two oat processing facilities in Saskatchewan, one in Yorkton (Poppowich Milling) and the Can-Oat Plant north of Saskatchewan. These two facilities will process somewhere in the range 300,000 to 320,000 tonnes yearly of whole oats. These whole oats would yield somewhere in the range of 100,000 tonnes of oat hulls. It is estimated that the economic impact of the oat hull project is approximately $400,000 yearly through the use of these 100,000 tonnes of oat hulls which previously had little or no value. It should be indicated that the use of the oat hulls is also allowing the increased processing of 300,000 tonnes of oats with a value to crop producers of over $35 to $40 million annually.

d) Other Crop Byproducts

During the course of the project many other crop byproducts were looked at, such as caraway meal, coriander meal, fish meals, pulse crop residues, spice screenings and other products such as the graff arriving from the McLeod Harvesting System. These crop byproducts were minor projects by nature and were largely funded by industry with some matching contributions usually from a government source such as the Agriculture Development Fund. It should be noted that these projects, while seemingly minor in nature, have major impact on the viability of the value added processing from which they come from. As an example, one of the aspects that was looked at was that of the fireweed residue arising from Phytokem's process of extraction. The plant residue which was fireweed was in a form which was wet and yet had very little value other than to be used in a landfill site. This particular product would also prove to be an environmental hazard. Uses were found so that the material was transported to a dehydrated plant in Outlook, dried and incorporated into alfalfa hay cubes and used in the elk industry. Elk have an affinity for fireweed and choose it in preference to other feeds. This has also led to another specialized product being marketed. Similarly aspects such as grain dust which are an environmental hazard are now routinely incorporated back into grain screening pellets. The main objective, of course, is to find a use for these particular products, extract some value if possible, or extract maximal value if possible and allow the value added processing to take place. It is unfortunate that the term "byproduct' has been coined and one individual indicated to me that these should perhaps be called co-products and not by-products at all as sometimes these co-products have more value than the original product being sought after.

2. Development of Specialized Varieties of Grains

a) Development of a high oil oat groat for pigs

The objective of this was to evaluate the groat of a high oil oat line for use as a baby pig feed. Funding was from an industry source for $14,800. The leadership was through the crop Development Centre and conducted in collaboration with the Prairie Feed Resource Centre and the Prairie Swine Centre. The objectives in terms of determining the nutrient value of groats from the high oil line of oats was through feeding and digestibility trials weanling and growing pigs. It was found that the high oil oat groat line would make an extremely satisfactory feed and superior to regular oat groats for baby pig diets. This high oil oat groat line is continuing to be developed and will be incorporated into the low lignin hull high oil line oat. The impact of development of a high oil groat would be to have increased digestibility and energy available for use in baby pig starter diets and also for other specialized livestock. This would give a competitive advantage to some of the Canadian feed oat varieties that could be used directly for this purpose and could be groated at any point in

time, whether they would be groated in Saskatchewan or groated elsewhere. This dual purpose role of having a feed oat and an oat groat that has specialized uses would add considerably to the competitive value of the oat grain as a feed crop.

b) The development of low lignin hull high oil feed oat

Preliminary work by the PFRC on ten varieties of oats supplied by the Crop Development Centre identified one variety with a hull characterized by a very low lignin content and 20% of conventional oat hull lignin content and relatively high *in vitro* digestibility. The objectives of this project were to evaluate the nutritional value of a low lignin hull alone and in combination with a high oil oat groat for ruminant animals and to develop a superior feed oat that will consist of a successful cross of the high oil oat and the low lignin hulled oat lines. Given the favorable agronomic of oats this project has the potential to develop a feed oat that would be superior to barley and thus would provide increased returns to producers. This project has been taken forward in cooperation with the Crop Development Centre and an industry partner, Super Oats Canada, that would drive the project forward and commercialize activities. The Crop Development Centre's responsibility in this development is toward that of breeding a low lignin hull high oil oat variety with the subsequent testing of the product with animals and evaluation in terms of utilization left to the PFRC.

This project is currently ongoing and has now done some of the original feeding trials on a simulated low lignin hulled high oil oat. It would appear from the initial breeding work that it is quite possible and readily achievable to obtain both of these characteristics in the same line or variety of oats. From the initial digestibility and evaluation work the energy density of this particular oat will approach that of corn. This is much superior in energy density to that of barley. This project has at least another year to go in terms of development before any major decision will be made by Super Oats Canada to pursue it or not. It would appear at this time that Super Oat Canada will see this variety or this development go to a commercialization stage. It is also indicated in this program that commercialization or development of the marketing plan will be starting in Year 3 of a four year plan to commercialize this particular oat variety. This particular oat variety is indicative of what is happening in the industry. The use of identify preserved grains that are grown under contract by crop producers and then marketing through a particular marketing channel to an end user as a total system will likely be the norm within the next 10 years. This type of system reduces risk for the crop producer and also assures the purchase of known quantity and known quality of product that the livestock producer receives. Other people, such as in the United States with high oil corn are doing very similar things.

Initial market studies show a potential initial market of two million metric tonnes for the enhanced oat variety. Even if one million tonnes is sold yearly, this is over $100 million of

new crop and one that in addition will significantly contribute to the competitiveness of the livestock industry. This project is ongoing and should likely continue to its end, particularly as it is being driven by a strategic industry partner, Super Oat Canada.

c) Identification of hulless barley varieties with superior feeding characteristics

The objectives of this project are to identify from existing hulless barley varieties those feed qualities that contribute to a superior livestock and poultry feed and secondly to establish the desired feed characteristics for the selection and development of new superior hulless barley varieties. It is anticipated that these hulless barley varieties will be taken by industry and commercialized as a superior hulless barley variety through contracting and identity preservation or other means to secure supplies for marketing. For the 1998, 1999, and 2000 crop year, particular varieties of hulless barleys were evaluated. These were varieties that were grown on several sites within the province so that site to site variation could be eliminated. Extensive chemical evaluations and particle size evaluation after processing was completed on the test varieties in all years of the project. Feeding value was determined in pigs and chickens on the hulless barley varieties. In addition, animal digestibility trials were done. This particular project was funded through the Saskatchewan Wheat Pool's First and Best Campaign of the University of Saskatchewan.

The results show that indeed there are one or two varieties of hulless barleys that are superior. Further, chemical analysis and calibrations to near infrared analysis were done so that superior feed grain samples can be rapidly identified and quantified as to their value. It is expected that these superior hulless barley varieties will be contract grown through one seed company in the next year. These varieties will be contracted to growers and a large hog operation has been sought as an industry partner so that the production can be followed completely through utilization providing considerable efficiencies within the grains livestock interface.

d) Development of a low phytate hulless feed barley

The Crop Development Centre has genetic material for low phytate barley on hand. Preliminary analysis by the PFRC has identified experimental lines of barley characterized by low levels of phytic acid and higher levels of inorganic phosphate in the seed. Phytic acid is the storage form of phosphate in the seed and is not digested very well by non ruminants. Phytic acid is also known to impair protein digestibility and undigested phytate phosphorus in the manure is a serious environmental concern. The objective is to breed a barley variety with a low phytate acid content such that the phosphorus would be much more available. Initial screenings on new lines developed indicate an increase in digestibility of phosphorus from these grains from 30% to approximately 65 or 70%. Potential economic impact of a

low phytate barley is considerable. As an example, it is estimated that it save producers $2 to $2.50 per tonne of complete hog feed, if they had access to low phytate grains. This saving would translate to 75 to 80 cents per pig marketed. Such a barley would give us a competitive advantage in markets where environmental problems from excess phosphorus are of concern. The low phytate barley project due to lack of interest in funding has been run on a minimum budget using some discretionary funds. The lack of commercial interest in a barley project of this type is understandable when one considers that the marketing of barley is not necessarily open to all agencies and as a result they must rely on the local feed barley market for their market place. In a situation such as this it is difficult to recover a premium or the true value of that particular barley in this type of environment.

e) Determining and measuring nutrient parameters to identify superior pea feed varieties

The objectives are to determine those chemical parameters that affect quality of feed peas as a feedstuff. These chemical parameters will be used to select superior feed pea varieties. In addition near infrared equipment will be calibrated to the key chemical constituents such as protein, starch, and fibre that determine feed quality. It is anticipated that the near infrared can then be used to quickly predict the nutrient and feeding value of feed peas for poultry and swine on a commercial basis. In addition, an objective is to determine the feeding value of selected feed peas in chickens and pigs through digestibility trials as a means to corroborate the predictions from chemical constituents. The project for selecting superior feed pea varieties is ongoing and was initially funded by the Saskatchewan Pulse Growers Association. This project is being led by the PFRC and has collaboration from the Crop Development Centre, the Prairie Swine Centre, and the Poultry Research group.

Each year for the last 3 years a total of 36 to 40 varieties of peas grown at two locations within Saskatchewan have been evaluated. Four varieties of these were chosen for digestibility trials. These trials only to corroborate and indicate that we were proceeding in the right direction. The impact of this project has been two-fold. Initially it has indicated to us that in selection of a feed pea economics must be involved as well as agronomic characteristics that must be considered when choosing superior pea feed varieties. As an example, if energy is to be increased, certain pea varieties may be quite digestible for older pigs, however, for poultry it is not nearly as digestible. In the effort to not to discard any useful and possible high potential lines that may be extremely suitable for pigs but not suitable for poultry, other means were sought to meet the requirements for poultry. Consideration then has to be given to seed size. Would a medium size pea which has good protein and energy for swine, be adequate for poultry if dehulled. This medium size pea has considerable advantages in terms of seed cost and in terms of agronomics of growing peas.

A second outcome of the project has been the requirement to look further at the structure of the carbohydrates within feed pea varieties. It would appear that there is considerable variation between feed pea varieties and the structure of the carbohydrates, giving them slightly more or less energy depending upon the type of situation. Satisfactory calibration equations have been developed for the fibre fractions ADF and NDF to NIR as well protein calibrations fat and now starch has been done to satisfaction with high enough correlation coefficients. This will mean that to evaluate feed peas rapidly and economically either for breeding selection or for evaluating existing feed peas in the commercial trade near infrared analysis can be utilized.

f) Other cereal grains

Other limited projects have been initiated with other cereal grains; however, there is work ongoing by the Poultry Research group looking at feed wheat selection and some limited work being done on selection of rye varieties for feed.

3. Canola Meal

a) Developing a processing system for improving the nutritional and monetary value of canola meal

The objectives are to develop a viable end line processing system to produce a canola protein fraction characterized by improved phosphorus digestibility protein and energy digestibilities when fed to production animals. This also includes a novel process for fractionation and enzyme treatment of the oil extracted residue of canola seed. Funding is from a single industry source with an agreement for non disclosure of funding or results. The collaborators within this project are the PFRC, Dairy Production Research Unit, Beef Research Unit, the Poultry Research group, and the Prairie Swine Centre. The leadership of the project is under MCN Canola Products Inc. The potential impact of a project of this type is substantial in that a commercial entity is driving the process forward on a confidential basis. In addition, the commercial partner has specific target markets in mind for the high canola protein fraction. Improvement of the canola meal in this manner can allow a canola type protein to access markets otherwise would not be available to regular canola meal. It also promises considerable value adding within Saskatchewan.

b) Canola meal quality program

The objective of the canola meal quality program was to develop a system for the differentiation of canola meal and to improve canola meal qualities by identifying quality parameters for canola meal. The project leader is through the PFRC with funding from the

Saskatchewan Canola Development Commission. This study is a long term study and has ongoing industry consultation with it. The results of the study indicate that a means of product differentiation with marketing of canola meal can be done by those wishing to market canola meal under a specific trade name. Canola processors, however, have not been interested in programs of this type simply because they feel that there would be no premium gotten on the market place for a specialized type of canola meal. This approach has met with some consternation by the Saskatchewan Canola Growers or the Canola Development Commission in that producers are not benefiting from improved canola quality and/or have no control on the canola meal quality that is being offered to the market place. The issue of added back screenings into canola is one that while perhaps additional dollars are being made by the processors, the impact on the overall market for canola meal is perhaps being reduced in competitiveness. Work is continuing to promote the competitiveness of higher nutrient meals and the increased use of whole canola seed which has direct benefit to producers.

4. Specialty Crops and Feed Products

a) The development of prairie based feed ingredients for aquaculture

The objectives of this program are to develop from prairie feedstuffs new feeds for aquaculture suitable for the commercial trade. The PFRC has identified development of prairie based feed ingredients for aquaculture as a high priority. Currently aquaculture is the world's fastest growing food production industry with sustained annual growth of 10% since 1984. The dietary requirements of fish are distinct from other species of production animals in that they require exceptionally high levels of protein in the diet as well as high levels of oil. Fish do not particularly digest fibre or starch very well. Problems occur in that fish meal from the capture of fish industry provides the bulk of protein and energy in most commercially available aquafeed diets at present. However, fish meal is expensive and the supply is becoming limited and inconsistent. Considerable opportunity exists to develop feed ingredients from plant sources that will replace a portion of the fish meal and fish oil in aquafeed formulation. There are opportunities to develop protein concentrates and isolates as aquafeed ingredients from raw material such as canola, peas, and flax and opportunities exist to develop pellet binders, coloring agents, and sources of oil for aquafeeds.

The Prairie Aquaculture Research Centre is a facility for conducting research on fish nutrition and physiology at the University of Saskatchewan. It is available for use and is operated by the Prairie Feed Resource Centre. The PFRC had obtained funding from the Agri-Food Innovation Fund of $200,000 over 4 years. This funding was made contingent upon soliciting industry participation. In May 2000 EWOS indicated that they would be willing to partner with the PFRC in looking at prairie based feedstuffs for aquaculture. EWOS is a large Norwegian fish feed manufacturing concern as well as fish marketer for the salmonid species. They are the largest in the world and have an office in Surrey, B.C.

Because EWOS is interested in obtaining ingredients value added processing in Saskatchewan would be necessary for any fish feed ingredient development. It should be understood that there are virtually no prairie based feedstuffs that would be suitable for fish feed in their present form. EWOS is now contributing $240,000 to $270,000 over the four year period. Projects that have been done through this agreement are the development of a dephytonized canola meal fines/fish hydrology product as an aquafeed ingredient. Funding came from Canamera Foods, Biozyme Systems, Agro-Pacific, and the Agriculture Development Fund. Leadership was through the Prairie Feed Resource Centre and the Saskatchewan Wheat Pool. The objective was to develop a system of dephytonization of canola meal fines when mixed with high moisture fish hydrolysate. The final product will be a protein feed ingredient for aquaculture consisting of a 50:50 mixture of fully dephytonized canola meal fines plus fish hydrolysate. The project has now been concluded and plans are being made to capture the canola meal fines as they have proved to be a valuable fish feed ingredient.

Other projects over the last year have looked at the use of pea protein concentrates, whole flaxseed, demucilaged flax, and now the development of a particular aquaculture feed from dehulled flaxseed. The results of these investigations into pea protein concentrates, whole flaxseed in a processed form and canola meal fines has been the base for knowledge and opportunities that are available for the combining of these ingredients into a fish feed ingredient that would replace all or part of the fish meal and part of the fish oil now found in aquaculture diets. The use of whole flaxseed extruded with peas in a product targeted to other livestock species has also led to providing commercial input and a means of commercial manufacture of some of these combined aquaculture feeds. The task that is now being done is to involve adequate commercial participation so that a highly specialized aquaculture feed will be the outcome. Industry partners to this end have been found and are in the process of developing a specialized aquaculture feed. Additional funding for these projects has been received from the Saskatchewan Flax Development Commission.

The future of the aquaculture program and the development of prairie based feed ingredients for aquaculture looks bright and has many opportunities. There is a reasonable degree of certainty that a specialized fish aquaculture feed will come out of this program, one that will have major impact on both the pulse crop area, the flaxseed area, and canola crop utilization area. It is expected that these crops will be involved in the same feed or perhaps in one or two separate feeds. Potential market for this type of aquafeed ingredient for EWOS alone has been estimated at about 150,000 tonnes annually. Additional markets could be sought beyond this and represents a substantial value added opportunity for Saskatchewan as aquaculture feeds are higher value feedstuffs.

5. Specialized Product Development

The development of new feed products and other collaboration with industry is an ongoing process. Previous reports submitted to the Agri-Food Innovation Fund have described development of Peas-Plus and many of the specialty products, however, it is worthwhile that these be revisited again as the PFRC is providing ongoing technical support of marketing and fine tuning these products to fit new markets and different market places.

a) Peas-Plus

A major industry affiliate of the PFRC, Saskatchewan Wheat Pool has developed a viable method for the economic removal of hulls from feed peas. In the initial stages of product development, the PFRC provided consulting, laboratory analysis, and nutrient digestibility and evaluation trials. The PFRC developed a technical brief used by industry as literature to support the marketing of the Peas-Plus. Recently a field test with a product with a large international poultry producer was successful in demonstrating the value upgrade of the product and the potential exists for substantial production and sales of Peas-Plus in the near future. Technical marketing support and marketing initiatives are being planned with several industry partners as a group. It should be indicated that the concept from this arose from the pea breeding work which indicated that to select specific feed peas for poultry may be long term and tedious. To quickly span this period of time and to also provide a product suitable for poultry dehulling was examined. This opens the avenue to not only dehull peas but splits and cracks that exist in the industry which are basically dehulled peas to have a higher value as a feedstuff than even regular bin run peas.

b) Genesis Organic Horse Feeds

The PFRC with the industry partner, Poplar Valley Farms in Prince Albert, developed a line of Genesis Organic Horse Feeds. Poplar Valley Farms is an organic grain producer and processor and is using some of the non food grade and other organic products available to create organic horse feeds. PFRC did evaluations, suggest combinations, and helped develop brochures and information surrounding the utilization of these organic horse feeds. Genesis Organic Horse Feeds are sold in Calgary, California, and Germany.

c) ExtraPro

ExtraPro is really a continuation of the development of the products from the pea-canola meal blends. The pea-canola pea blends were successful as an original product that provided a high quality protein basically targeted for the swine industry. ExtraPro is an extruded whole canola seed and pea mixture specifically targeted for the swine, poultry and dairy industries to provide a high quality oil and protein product for livestock use. The product

was developed in cooperation with Oleet Processing in Regina. The processing technology has been developed and has now evolved to include the making of a unique bypass fat and protein supplement for cattle. Technical support has been provided in the form of feeding trials for dairy and for poultry and technical support was provided for the development of the product through the extrusion process and development of brochures that would be suitable for marketing internationally and domestically. Technical support has been provided to Oleet and its marketing agent by providing seminars not only in Canada but in areas such as Korea and Taiwan. It should be noted that Oleet Processing is now the largest user of off-grade canola in Canada. In addition the company has grown from one extruding machine to now running three extruders simultaneously and has led to the development of other extruded products for the feed industry.

d) A-Plus Supergreen

A second product from ExtraPro was developed in response to marketing studies in south east Asian market as well as that required by domestic feed market. The product A-Plus Supergreen is a mixture of ExtraPro plus dehydrated alfalfa. This mixture provides a superior amino acid balance that is conducive to supporting high milk production with high producing dairy cows. In addition, the product contains fat and is not conducive to causing acidosis in these animals and therefore is very beneficial as a high quality protein source and supplementing as a high quality high energy forage source. This product basically was developed in response to dwindling dehydrated alfalfa markets in Asia. The reduction in markets for dehydrated alfalfa comes from the lack of use at the farmgate level for direct feeding of alfalfa pellets and is now only used in the compound feed industry. Use in the compound feed industry has restricted dehydrated alfalfa as a commodity and has to compete in those commodity markets. A-Plus Supergreen has been very successful in the Taiwan and Japanese markets to help recapture some of the direct feeding market. It is highly palatable and packs a performance punch. Research and technical assistance was given in the development of these products from initial concept and also to commercialization of these products into the market place. These products, both ExtraPro and A-Plus Supergreen, are leading edge products technologically and as a result they have a good reception in the market place as they are perceived as new, innovative, and improved products.

e) Lin Pro

Lin Pro, a product made from extruded whole flaxseed and legumes, is a product specifically made and targeted to provide additional benefits not available in other feedstuffs. These additional benefits are as an immuno stimulant feed, and other health benefits plus nutrient behavior that other products cannot provide. Specifically, this product is targeted towards dairy cattle for altering milk fatty acid composition, to poultry for the production of omega 3

eggs, for swine production to assist sows at farrowing time and in terms of an immuno stimulant feed and for horses as a means for providing a protein and high energy feed supplement. Product support for Lin Pro has been given through dairy feeding trials, a poultry feeding trial, as well as technical support in its development and concept with Oleet Processing of Regina and Werner Agra Ltd. as the marketing agent. This product is currently being launched in the market place and has considerable potential to becoming a highly specialized feed product. This product, while its impact is not yet known, is also leading the way for the development of a specialized aquaculture feed product that would be comprised of perhaps whole flaxseed, pea protein concentrate in various amounts of canola ingredients. This again would not be possible without industry participation. Funding came from the Saskatchewan Flax Development Commission.

6. Other Value Added Activities

There were numerous other value added activities that were taken on by the Prairie Feed Resource Centre that might be considered as projects of a smaller nature. Typically financial support was given directly from the commercial entity and were directly driven for commercial purposes. These other value added activities were:

- support for Phytokem to utilize byproducts of extraction as specialized feeds, eg. fireweed for elk.
- Development of a fresh water fish meal for Trihex Corp.
- Development of organic horse feeds for Poplar Valley Organics.
- A study of the McLeod Harvesting System, a unique grain harvesting system.
- Peas-Plus, a superior feed product for the Saskatchewan Wheat Pool.
- Technical market support domestically and internationally for Saskatchewan feed products.
- Development and production of a dehydrated large alfalfa hay bale and small double compressed dehydrated alfalfa hay bale.
- Technology transfer through seminars and publications domestically and internationally.
- The use of grain screenings for poultry. Use of grain screenings for beef cattle.
- Use of byproducts feeds from the spice and herb industry, eg. caraway meal.

This completes many of the projects that the Prairie Feed Resource Centre felt was in its mandate.

Other Research and Development Initiatives

The PFRC is also involved in initiating and working with other projects considered as basic research areas. These projects were:

- The expansion of activities and laboratory feed evaluation technology in support of research and development activities of PFRC affiliates. The PFRC developed the capability to run laboratory analysis and feed evaluation in support of applied feed research and development activities for its members or its affiliates. This service offers a full spectrum of chemical and nutrient analysis and provides an important link between in house research and development activities and that needed for industry. The PFRC and members of the Department of Animal and Poultry Science. During the period covered in this project laboratory activities continued to increase. Technicians were hired to fill this void as the need arose.

- Small intestinal digestibility of methionine and 2 hydroxy 4 methylthiobutanoic acid in control and germ free chickens. The project has as its objectives to assess the effects of gut microflora on the digestibility of methionine and the hydroxy analog of methionine in poultry. The funding for this project came from Degussa Corporation and is under the PFRC leadership and has as its collaborators the Animal Biotechnology Centre. This project has now been completed and has provided to the funders the technical data indicating the digestibility of methionine product in control and completely germ free chickens.

- Effect of Saskatchewan feedstuffs on intestinal microbiology of pigs. The project leader is the PFRC and is looking at the effects, if any, of any probiotic response from Saskatchewan feedstuffs that there may be on the intestinal microbiology as it now exists in pigs. This project is ongoing and is at the initial stages of investigation.

It should be indicated that many of these projects are done in coordination with other groups and/or have involved strategic industry partners. As a result, identification of a single entity responsible is not always clear. Irrespective, the PFRC in the preceding projects has played a key role in innovation, recognizing opportunities and developments that must take place for economic contributions. The unique position and mandate of the PFRC allows it to play a role of initiation from its own original concept or to facilitate the development of other technologies from research or industry. As a result, the impact is substantial in that it formalizes and captures the total potential opportunity. This concludes the major project activities for the PFRC and while these activities have had merit and have changed over the years, the change was required for new activities. It is expected in the future that similar activities such as the development of new varieties or assisting with the development of new

varieties of feed grain developing new feed products will continue at a high level of innovation and technology use as well. However, coupled to this, and based on past experience, there is much potential in the area of crop processing and fractionation as a value added process that would generate products for food, feed, or industrial use. Too many activities that look at crop processing of fractionation approach it from a singular viewpoint. These types of projects should be approached from an interdisciplinary and multi-disciplinary approach. One example has been the development of the flaxseed and using it as a source of omega 3 fatty acids that has specialized application in feeding. One new product has been produced, Lin Pro, which has specific targeted application in swine, poultry, and lactating dairy cows to provide either omega 3 eggs or healthy milk.

The flaxseed for aquaculture can be further enhanced through the elimination of anti nutritional factors such as mucilage. This is being pursued and further products such as pea protein concentrate are also being pursued that could be mixed with this dehulled flaxseed. Processing of peas to yield starch and pea protein concentrate is being actively pursued with one and possibly two groups. In one case the starch is intended to be used for ethanol production and the pea protein concentrate can be used for food purposes and high end feed markets, such as aquaculture. This then illustrates what probably will be required to motivate and move value added processing particularly in the crops area in Saskatchewan. It is important that this type of approach be taken.

Consulting and Technology Transfer Activities

The PFRC has a second main function, that of consulting and technology transfer activities for the feed industry. During this project a great deal of targeted technology transfer activity surrounded many of the projects either in support of feed development or in support of community facility development or in the support of marketing highly technical feed products. In addition to these there are examples of many other technology transfer activities that should be noted. These were:

- Providing technical service for products developed by the PFRC both domestically (British Columbia, Alberta, Saskatchewan, Manitoba) and internationally (Mexico, Panama, United States, Taiwan, Japan, Korea, Thailand, China). There was local technical support for industry affiliates given to diversify feed products, some in support of feedlot developments, support for grain processing facilities, support through responding to 400 phone calls per year, as well as 15 to 20 speaking engagements at producer based meetings in the province.

- PFRC was also active in hosting delegations from other areas of Canada, United States, and internationally in one or two day seminars on Canadian feed utilization. Delegations were from south east Asia, North America, Europe, and Australia.

- PFRC through a strong alliance and in cooperation with the Canadian International Grains Institute (CIGI) helped host and provide lectures to CIGI course participants over the course of this project on a twice yearly basis.

- PFRC was involved in education programs as well. It had provided one week courses for industry such as the Feed Rite group, the Highline group, and also put on a two week intensive dairy nutrition course for the Chinese dairy industry that was sponsored by Semex Canada. These participants from China came to Canada and attended the course at the University of Saskatchewan. The course level was given at a post graduate level and was carried forward by partnering with resources in the Department of Animal and Poultry Science.

- PFRC has held during the course of the project three feed information days that were open to the public and featured well known guest speakers to address current topics of interest. These information days were well attended and received many good comments.

- PFRC published *Feed News* and *Feed Notes* on a regular quarterly basis over the term of the project. The *Feed News* featured articles either on PFRC activities or articles dealing with new and recent developments within the industry. The *Feed News* project and provision of communications has been well received by the public.

- PFRC has established a website at www.feedresources.com. The website was developed and lists the PFRC members and also lists some of the recent *Feed News* and publications from the Prairie Feed Resource Centre. PFRC has now accumulated a database on feeds and feedstuffs and will be placing it on the website for general use.

Other Technology Transfer Activities of Major Significance

PFRC has continued to develop and be active in contributing to help facilitate a cooperative extension program between PFRC and the extension group of Saskatchewan Agriculture and Food. This primarily has involved Murray Feist and other members of Saskatchewan Agriculture and Food. The signing of the Memo of Understanding (MOU) between the Department of Animal and Poultry Science, PFRC, and the College of Agriculture with the National Agricultural Cooperators Federation (NACF) in Korea for the provision of specific expertise related to feeds and feeding is an initiative that is showing its potential. NACF has approximately 35% of the feedmill capacity in Korea which represents 4 to 5 million metric tonnes of feedmilling capability each year. This MOU calls for the sharing of technology

through seminars in Korea as well as the development of research programs specifically for the NACF. This project is currently ongoing with seminars having taken place with exchanges of information and is now in the throws of planning for a major research project solely funded by the NACF in Korea.

PFRC on a similar type of project has been involved with the development of the MAFIC Feed Centre in Beijing, China. PFRC was involved from the initial study phases through its development to providing resources for technical seminars and developments on site in Beijing. PFRC has maintained a strong link with the MAFIC Feed Centre with regular exchanges of technology.